Activation Energies of African Dark Earth Soils

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Introduction

- **Soil carbon sequestration** has become promising outlet for carbon offsets
- **Different carbon sources last longer**: as organic materials decay and are digested by soil microbes, CO_2 is respired
- **African Dark Earth (AfDE) soils are extremely carbon rich** as a result of prolonged introduction of biochar and other litter products
- **Different carbon bond activation energies exist within the a given soil**, reflecting the “persistence” of different organic carbon sources[1]. Carbon bonds with higher activation energies are harder to digest, lasting longer
- **Understanding the distribution of activation energies** within a soil gives insight into sequestration trends

Conclusion & Future Work

Conclusion

- The distribution of activation energies is closely related to a sample’s thermal analysis curve
- Using RampedPyrox activation energy values is a viable method for showing differences in persistence trends
- Sample characteristics like soil order and site location explain difference in thermal analysis results, whereas site location and country aren’t as useful.

Future Work

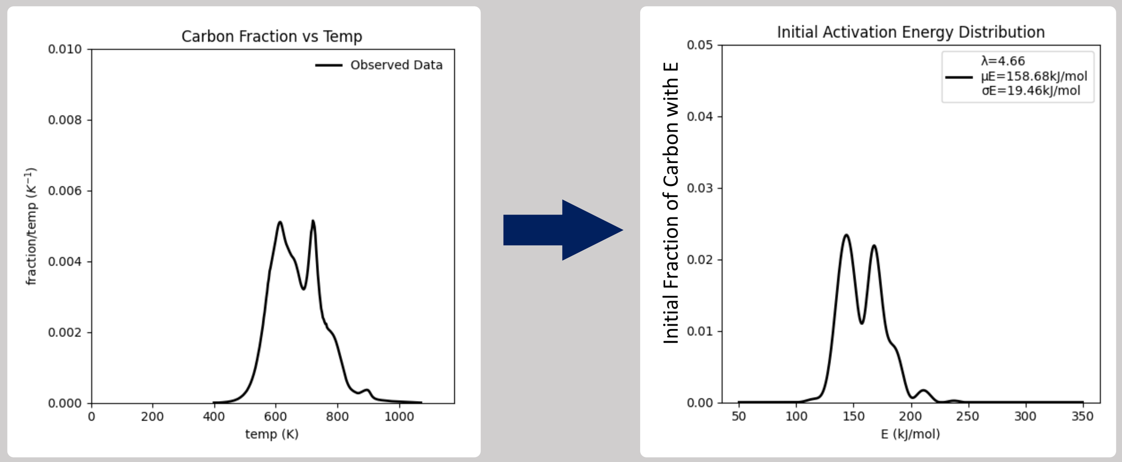
- Apply RampedPyrox.py to new set of Ghanaian AfDE/AS soil samples
- Investigate other Activation Energy calculation methods
- Apply more rigorous clustering techniques to PCA results

Methods

Worked from a previously collected set of 130 soil samples from 11 sites across Liberia and Ghana. Samples were taken at varying depths of both AfDE soils from the sites, as well as non-AfDE adjacent samples (AS) to serve as references[2]

Samples were previously run on a Netzsch STA 449PC Jupiter simultaneous thermal analyzer equipped with an automatic sample carrier (ASC) and a type-S platinum/ rhodium (Pt/PtRh) sample carrier, producing plots of Temperature vs. Carbon Dioxide concentrations for analysis[1]

Used the RampedPyrox Python module to create Initial Activation Energy Distributions (IEAD) This uses Tikhonov Regularization to solve a matrix of time/energy data based on the Arrhenius equation[3]

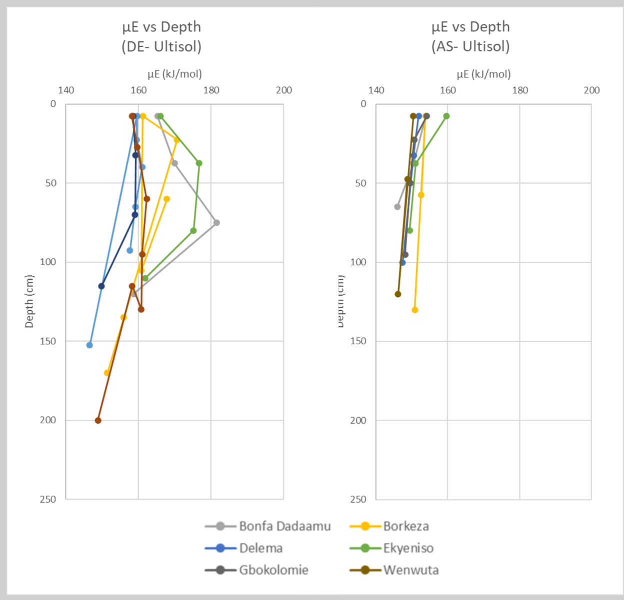


Used Principal Component Analysis (PCA) to compare Thermal Analysis plots of different soil samples This allowed comparisons of soils separated by different factors like depth, site location, and soil order

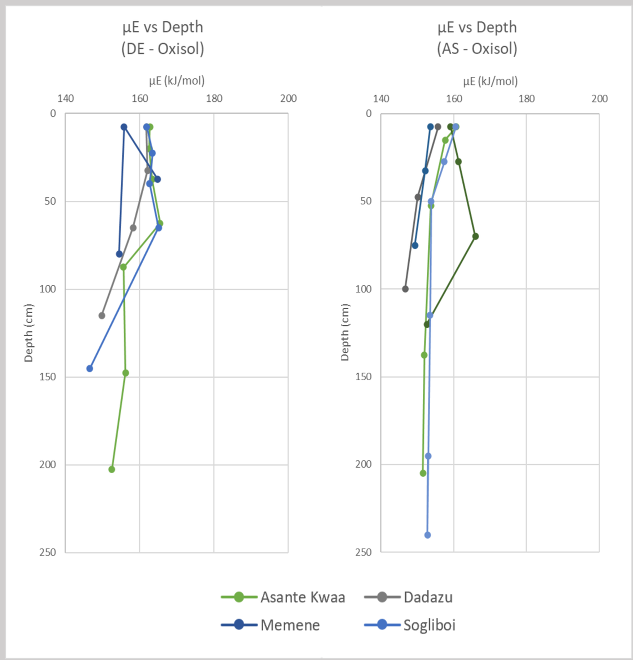
Results

Graphs of Average Activation Energy (μE) with Depth

Ultisols

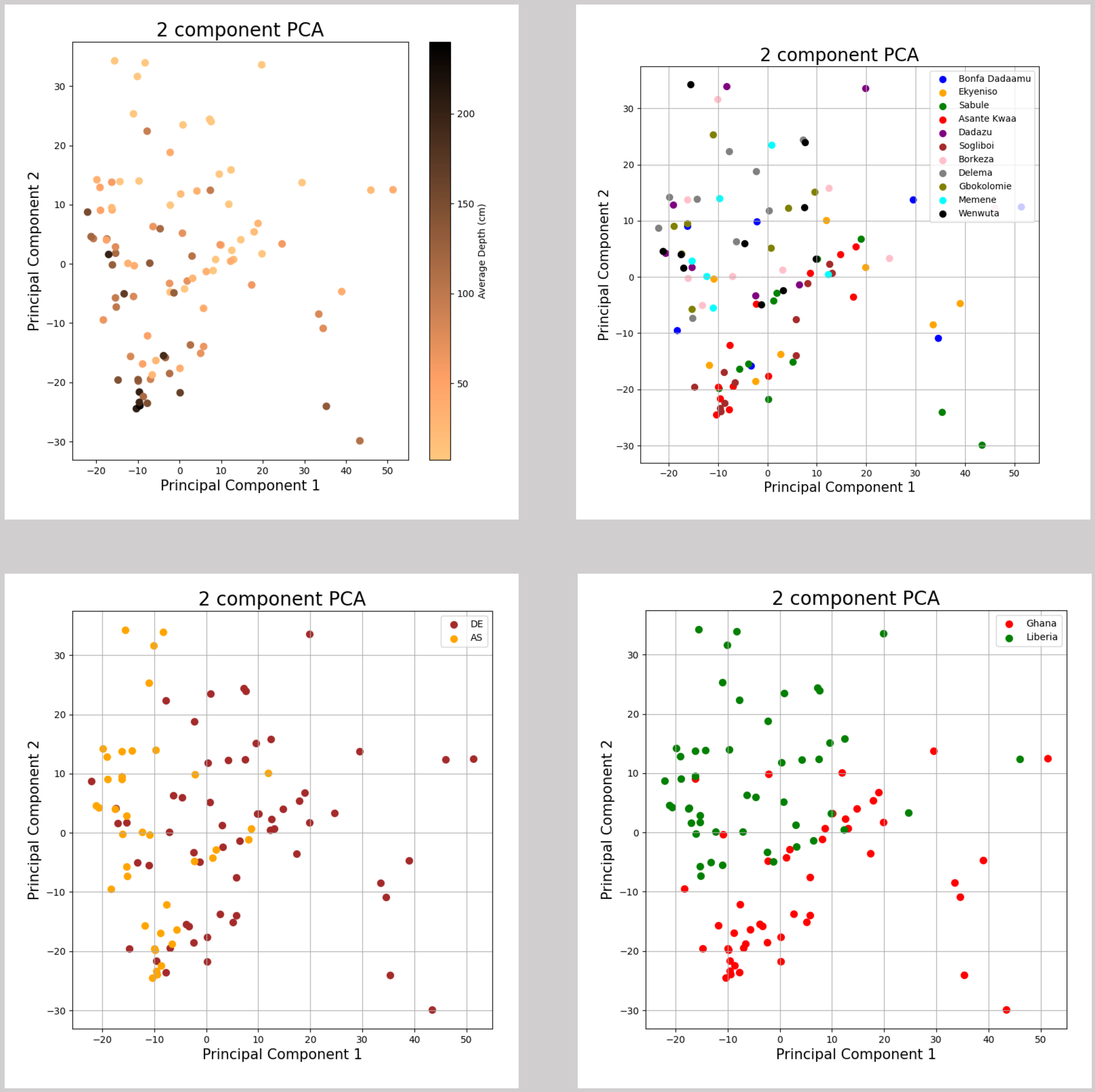


Oxisols



Graphs are separated by soil order (Ultisol vs Oxisol) and soil type (Dark Earth vs Adjacent Soil)

Principal Component Analysis Results labeled by depth, soil order, and soil type



Acknowledgements & References

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References

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